HCAL tile testing at BNL

Abhisek Sen, Megan Connors,
Andrey Sukanov, John Haggerty

Beam Test - April 2016
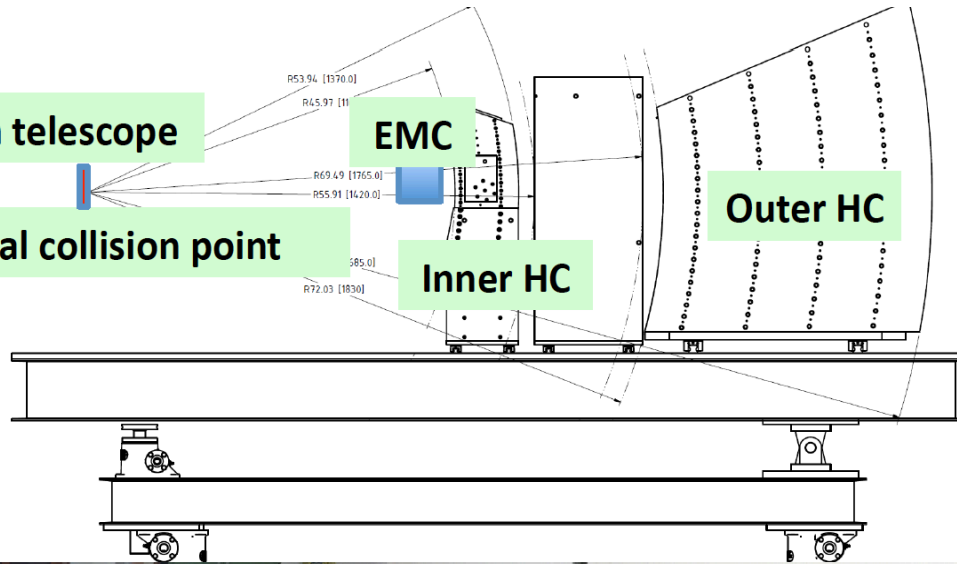
2016

XY Si strip beam telescope

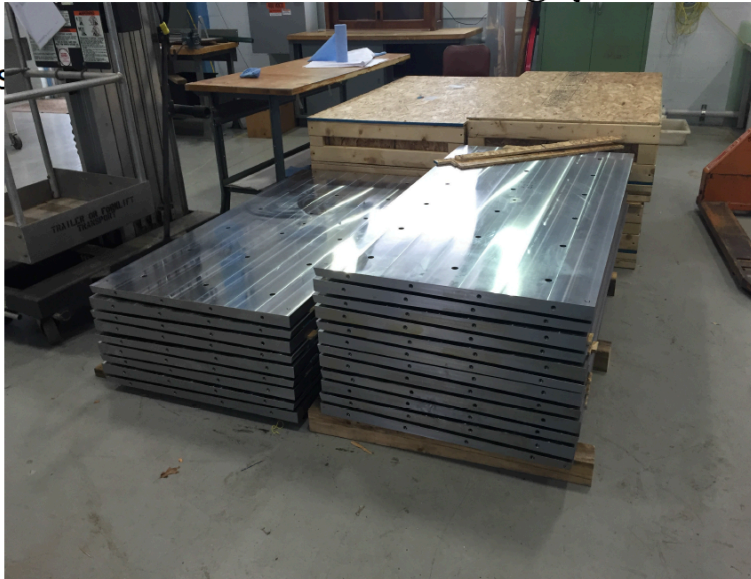EMC

Virtual collision point

Outer HC

Inner HC

R53.94 [1370.0]
R45.97 [11
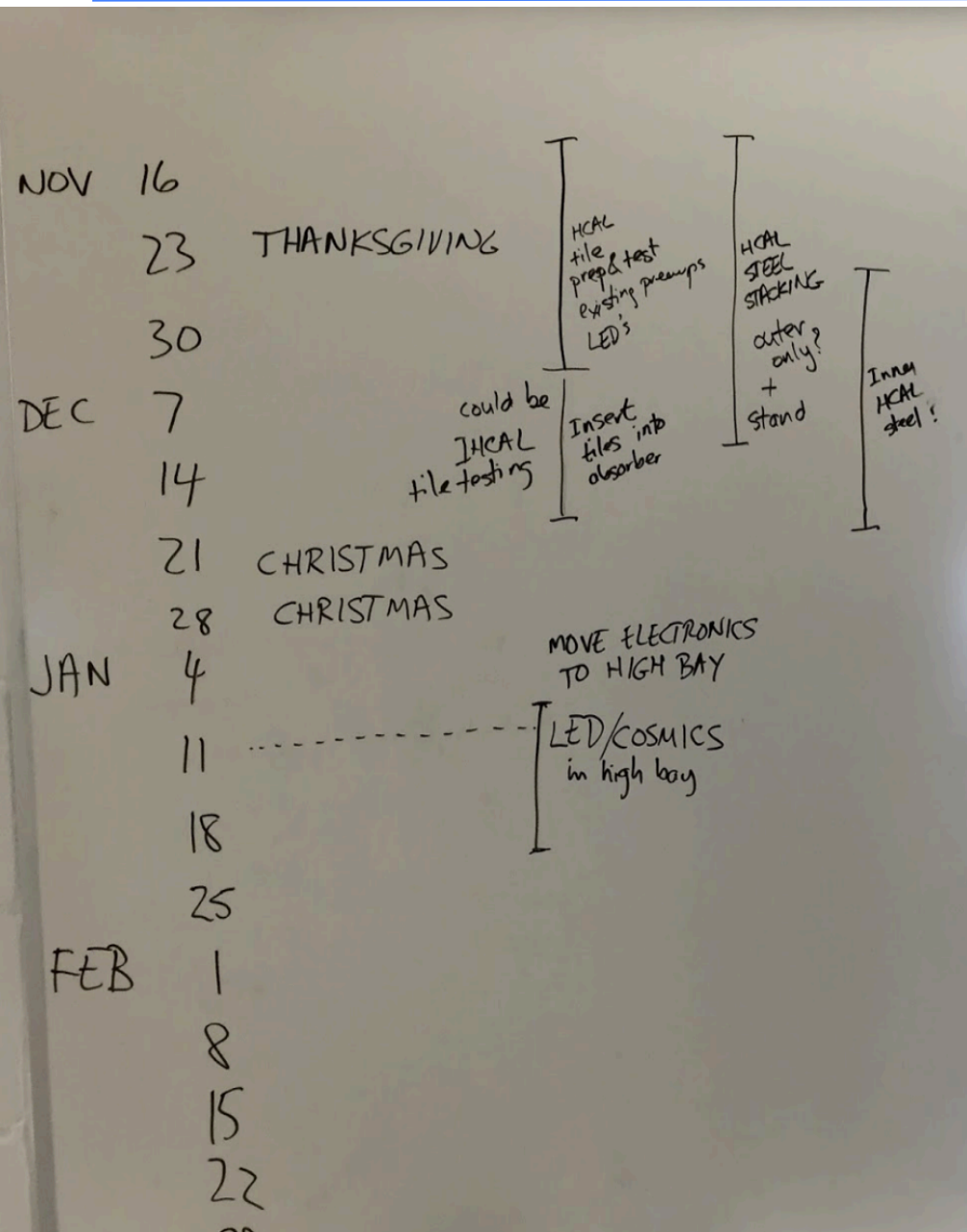R69.49 [1765.0]
R55.91 [1420.0]
685.0]
R72.03 [1830]

➤ Total tiles : 160
  -   80 InnerHcal
  -   80 OuterHcal
➤ Total 32 towers.

Schedule

John Haggerty's hallway planner

Significantly running behind schedule.

Initially planned all tiles should be cosmic/LED tested by December and move to high bay on January.

What's the status?

➢ Received shipments of tiles, SIPMs.
➢ SIPM holders have been 3D printed.
➢ Labeling all the tiles and visual inspection. Database created.

https://docs.google.com/spreadsheets/d/1tj4oqnrEjb-JKBgQP0JEMEtcm2WcbDdqQLHkehOJChI/edit?pli=1#gid=456280661

|	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Module	Uniplast model number	Both fibers exist? (yes/no)	Fiber depth good? (yes/no)	Fibers centered? (yes/no)	Fiber angle 45 degree? (yes/no)	Gaps between fibers?	Inspect fiber polish	Fibers sticking out?	Tile size okay?	Other Comments	Picture	Additional pictur
2	OH-2-1	SP02-200-108	yes	yes	yes	yes	Good	Good	No				
3	OH-2-2	SP02-200-108	yes	yes	yes	yes	Good	Good	No				
4	OH-2-3	SP02-200-108	yes	yes	yes	yes	Good	Good	No				
5	OH-2-4	SP02-200-108	yes	yes	yes	yes	Good	Good	No				
6	OH-2-5	SP02-200-108	yes	yes	yes	yes	Good	Good	No				
7	OH-2-6	SP02-200-108	yes	yes	yes	yes	Good	Good	No				

To-do: Prepare all the tiles
➢ Light tight the tiles.
➢ Screw in the holders.
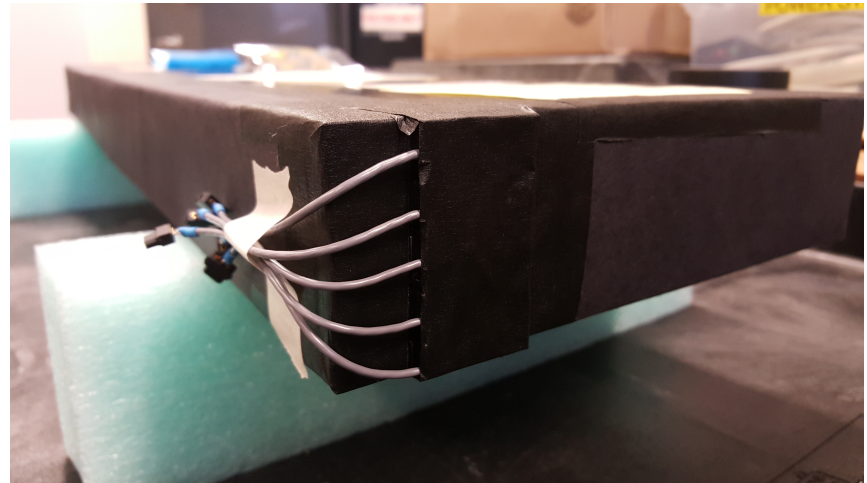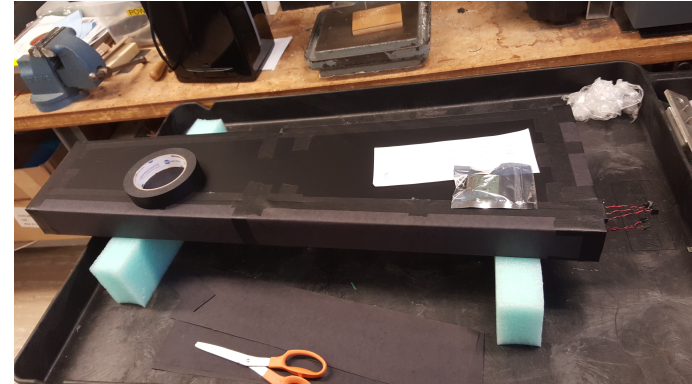➢ Soldering the SIPMs and make the connectors.
➢ Put in the LEDs.

Only 5 inner and 5 outer tiles are ready for testing so far. Prepared by Mike Lenz.

Towers for test
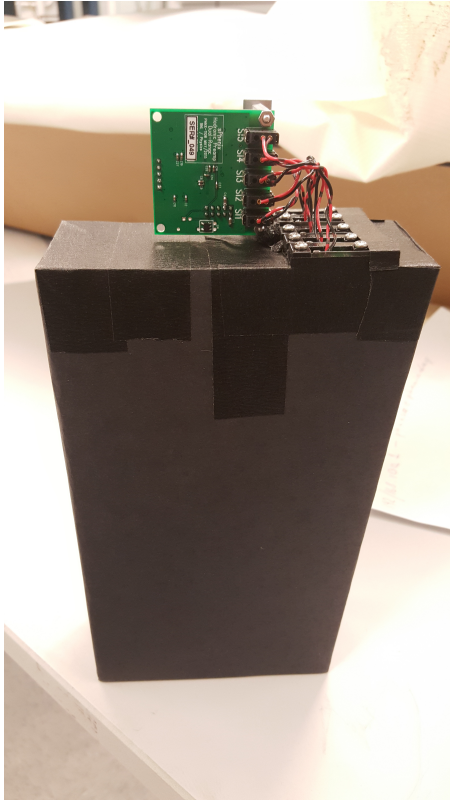
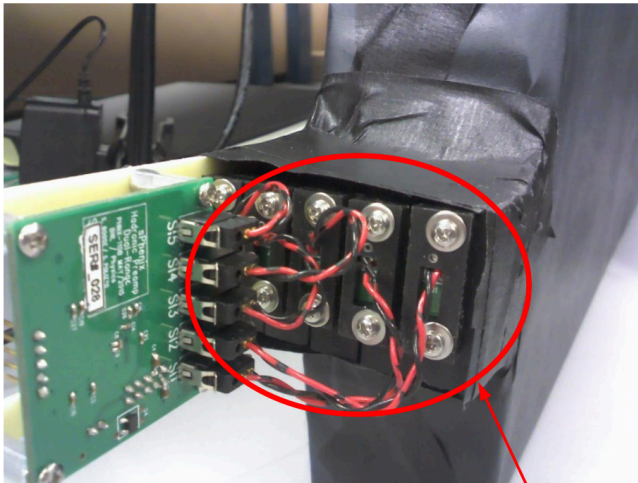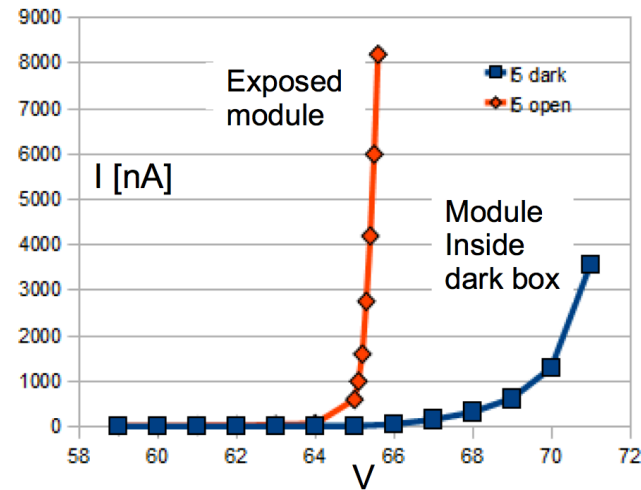New holders, new connectors.

Light leak test

❖ We first did a light leak test.

Old Hcal Module   Light leakage

Exposed module

I [nA]

Module Inside dark box

- I5 dark
- I5 open

IV of the old HCal module,

There were a lot of light leakage with old holders.

IV of the HCal Outer Module

I[nA]

- I5
- I5 Dark

V
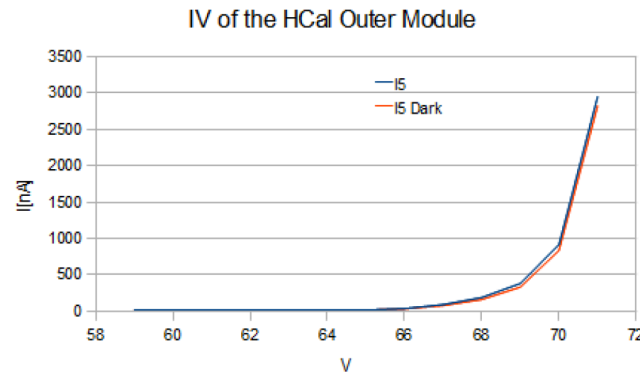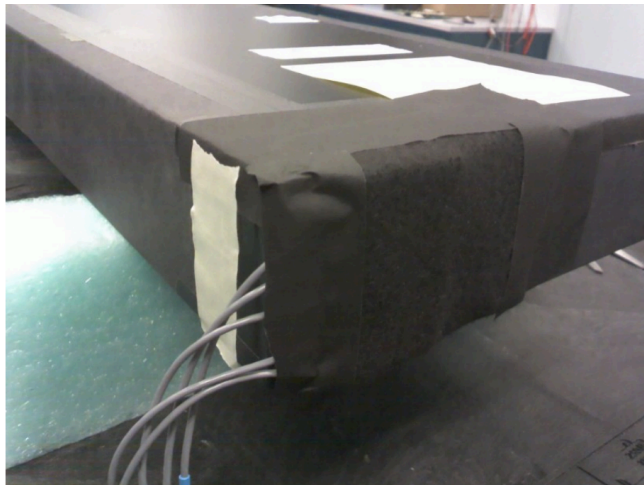
Red line: module in the dark box, dark room.
Blue line: module exposed to ambient light.

Almost no light leak.

Cosmic setup with small tiles

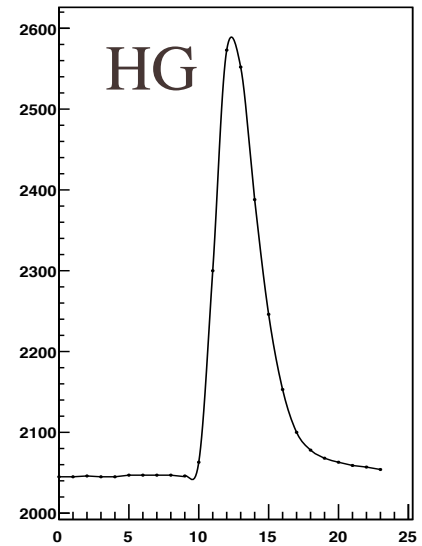5 tiles are connected to 5 separate preamps. All get same bias voltage from a distribution board.

DAQ
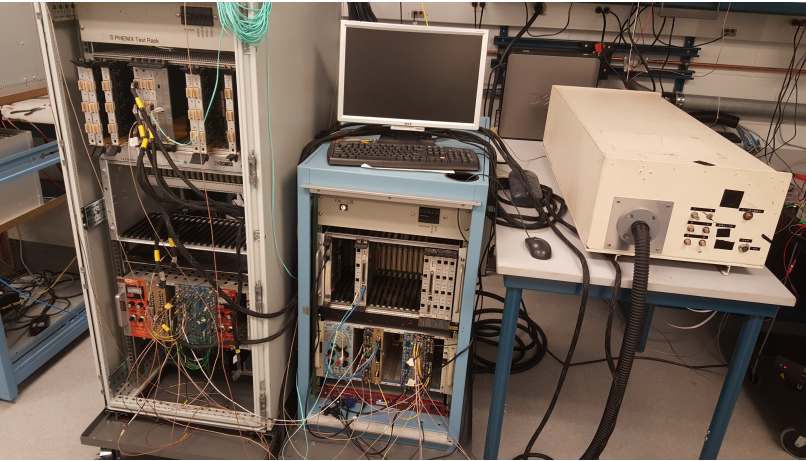
HBD design

➢ 60 MHz sampling frequency.

➢ 14 bit ADC.

➢ 64 channels per board.

➢ Collects 24 samples.

➢ Each sample ~16ns, total ~400ns. (??)

➢ Trigger primitives based on 2x2 tower geometry.
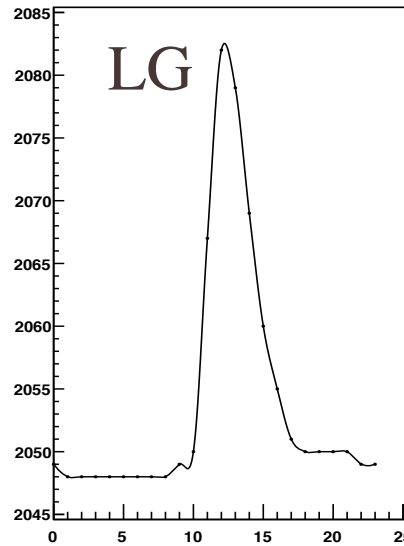
Cosmic signal in a tower
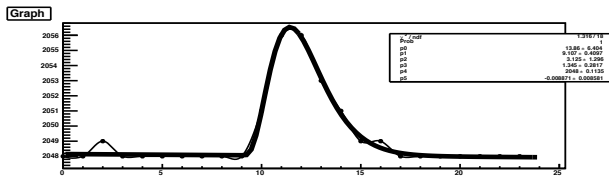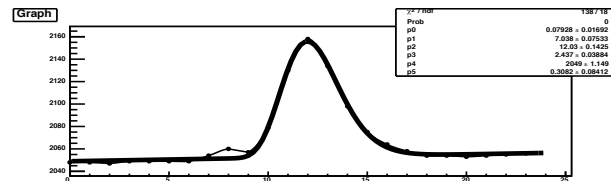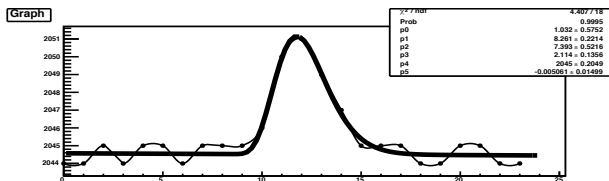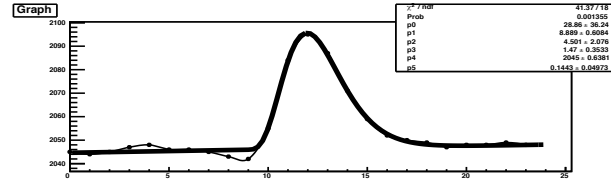

LG   HG

Tile 0
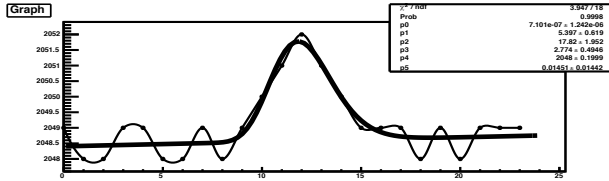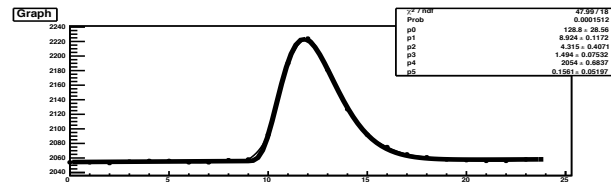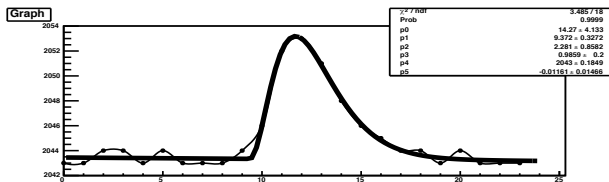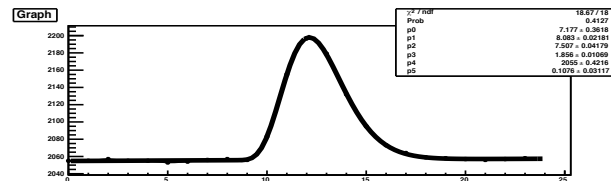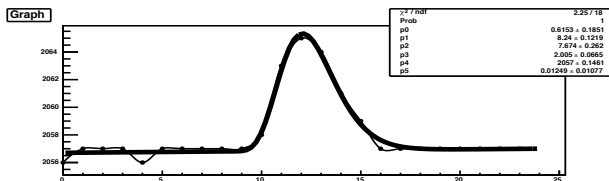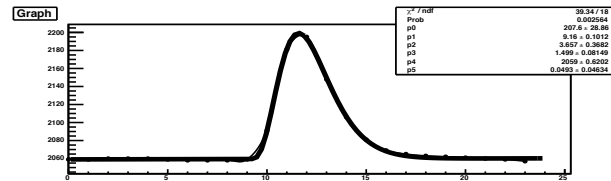
Tile 4
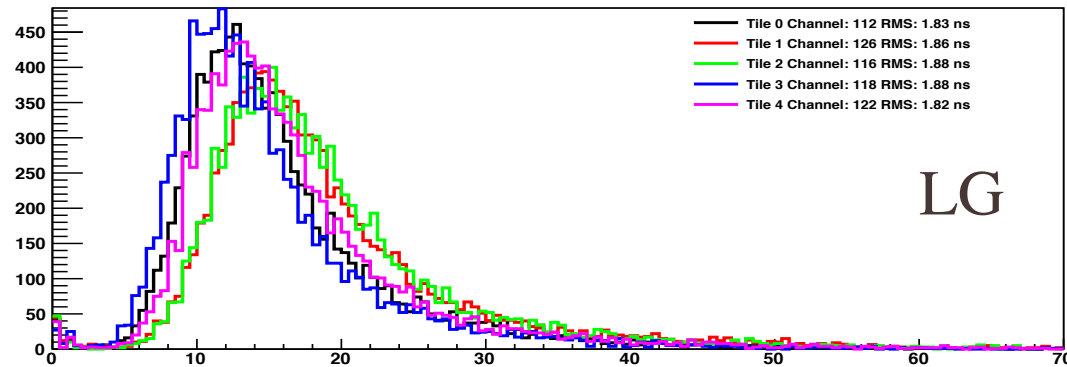
A convoluted power and exponential fit works better than Landau fit.

Cosmic signal from the small tiles

HG

Tile 0 Channel: 112 RMS: 1.83 ns
Tile 1 Channel: 126 RMS: 1.86 ns
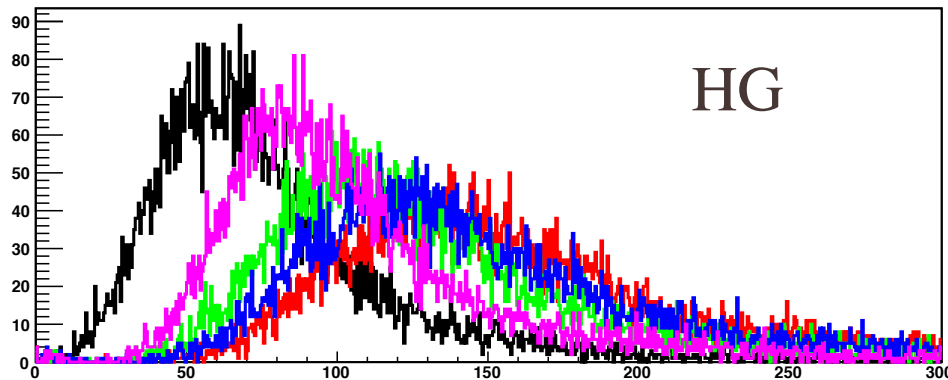Tile 2 Channel: 116 RMS: 1.88 ns
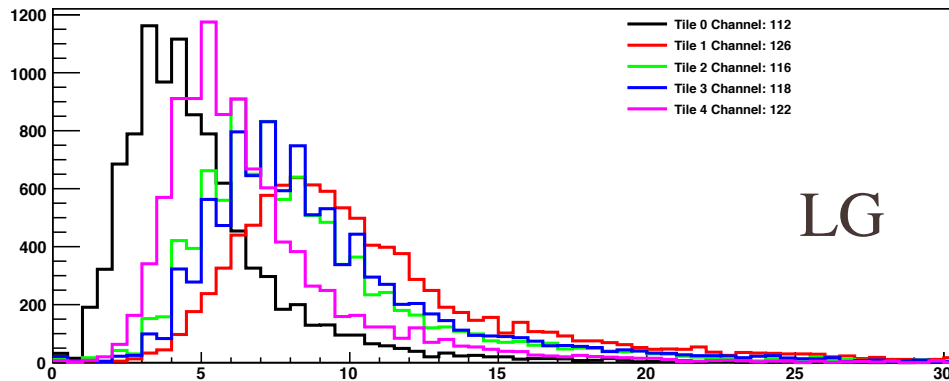Tile 3 Channel: 118 RMS: 1.88 ns
Tile 4 Channel: 122 RMS: 1.82 ns

LG
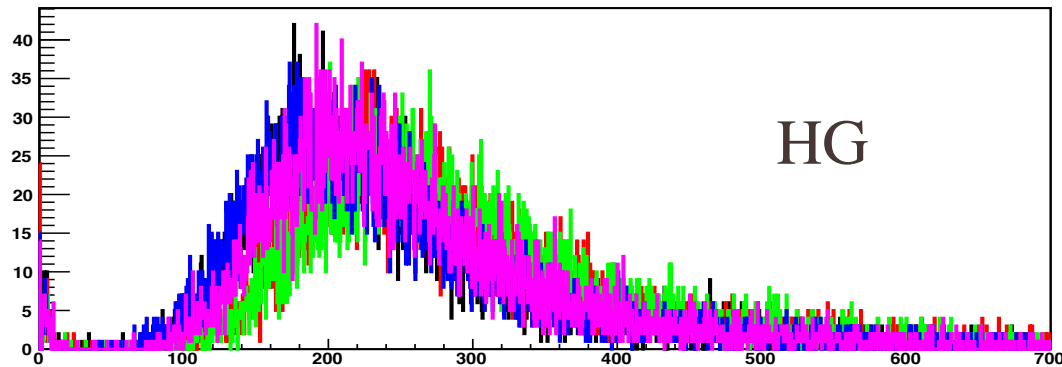
➢ Signal from all the tiles looks very consistent with each other.
➢ Consistent with earlier estimate from Edward, 30Pixels/MIP, 1Pixel~5mV for HG.

Cosmic signal with the big tiles


Significant variation of light output among the tiles.

➤ Are these tiles production or pre-production tiles?
  o We are not sure. Maybe pre-production tiles. Then the the light output variation is expected.

➤ Why the light output is smaller?
  o We don't know. That's a big mystery.

➤ Where the relative difference coming from?
  o We did few investigations (later slides)

Investigation 1: Pixel peaks

Tile 0

Tile 3

Tile 1

Tile 4

Tile 2
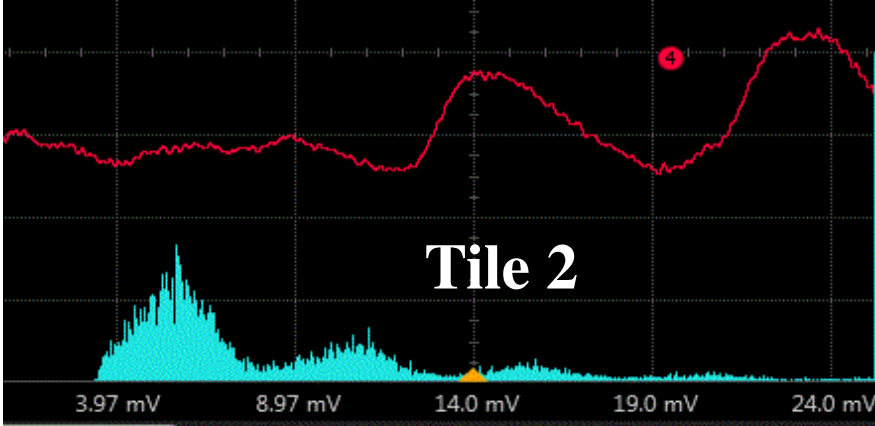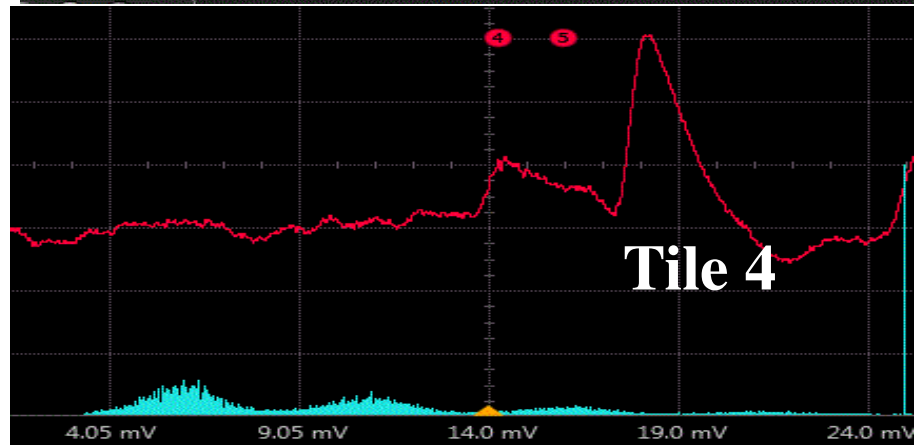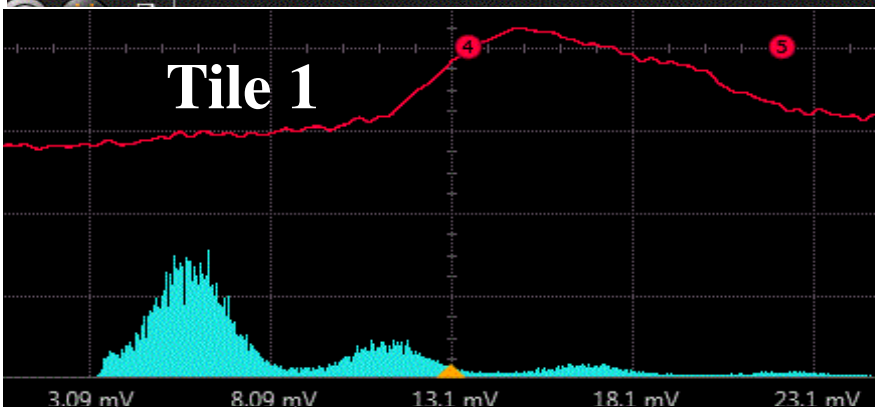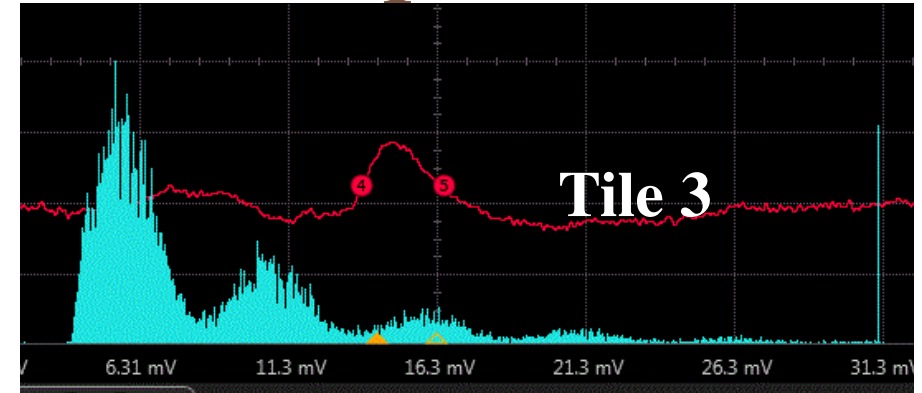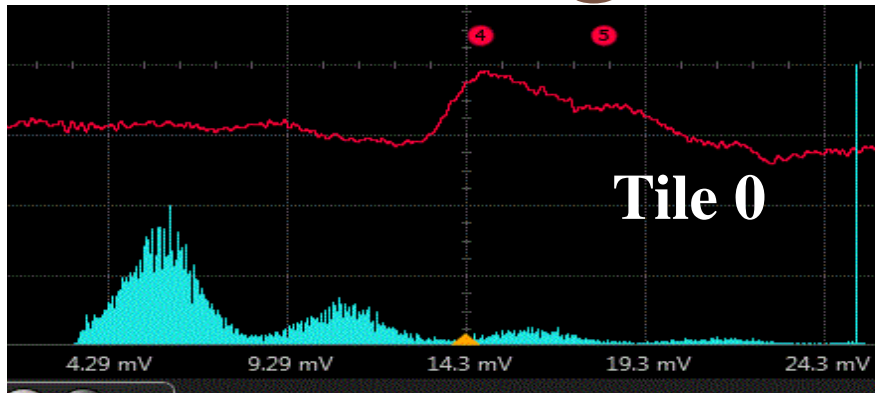
All at 70V.
1 Pixel ~ 5mV for all the tiles.
Consistent with each other.

Investigation 2: Tear it down

Light leak

Alignment problem

Bad connectors

Tile 0
Tile 1
Tile 2
Tile 3
Tile 4
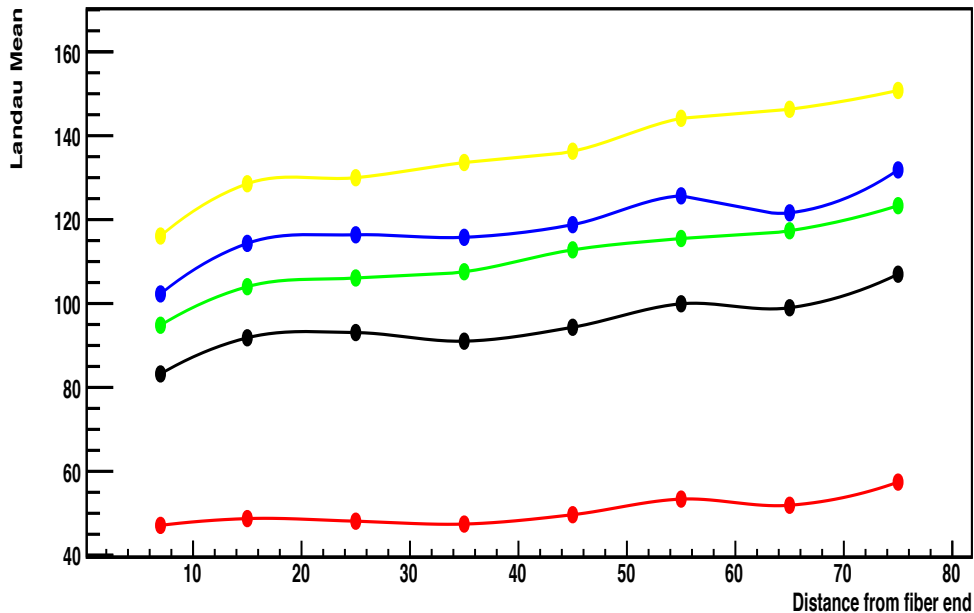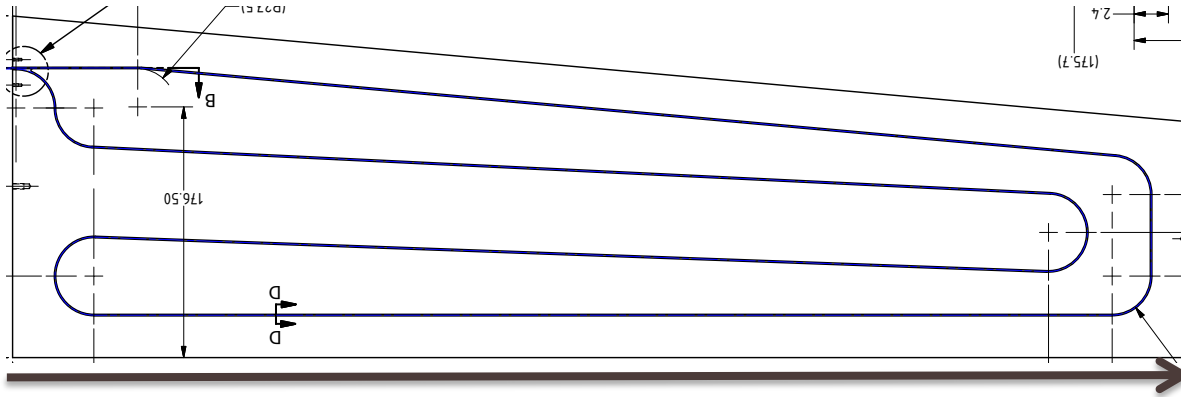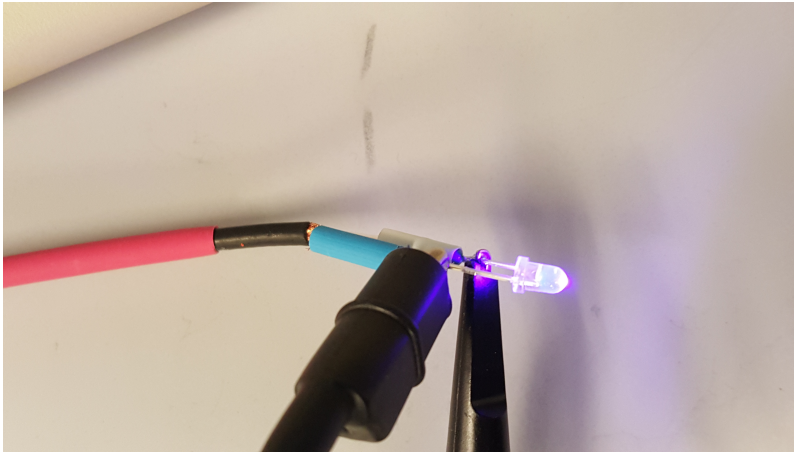
ADC counts
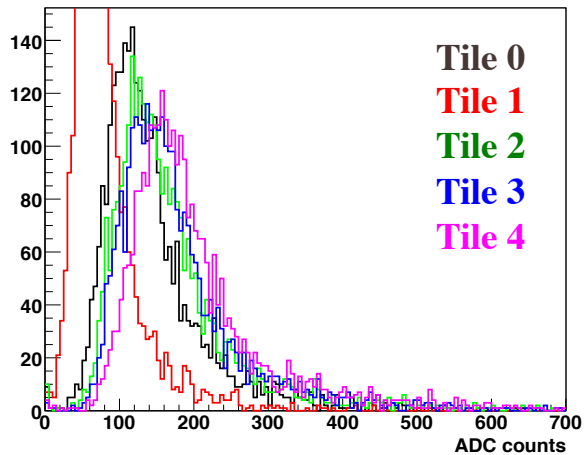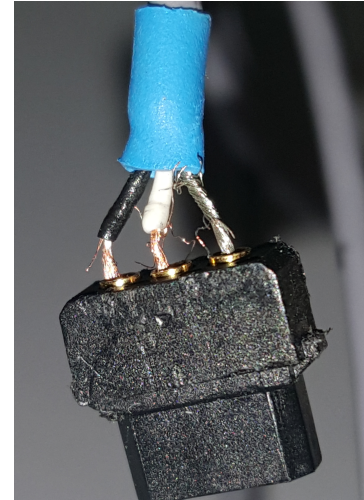
Middle tile has bad alignment. This is one culprit.

- ➢ Cosmic counters with active area 10.5cm x 12cm moved along the tiles.
- ➢ Very hard to get good position resolution.
- ➢ 1 hour run, ~3000 events/run.

Light output increases as you move away from the fiber end. Very surprising (?).

Investigation 4: LED scans

**Tight Tolerance Ultraviolet LED Lamp TZ Series (T1, 3mm Round / 15° & 30°)**

BIVAR

UV3TZ-XXX-XX

- ♦ **RoHS Compliant**
- ♦ **Low Power Consumption**
- ♦ **Low Current Requirement**
- ♦ **High Efficiency**
- ♦ **Tight Tolerance of Wavelengths**
- ♦ **Equipped with a Protective Zener Diode Built-in**

Bivar **UV3TZ-XXX-XX** Tight Tolerance Ultraviolet (UV) LEDs have peak wavelengths in the highly desirable ranges from 390 to 405nm with a tight tolerance of +/-2.5nm. These UV LEDs also have a built-in Zener Diode providing protective circuit against electrostatic discharge (ESD).

Applications: Industrial curing, fluorescence disclosing and verification, air purification, medical and biomedical applications, dermatological equipment, and hazardous materials detection.
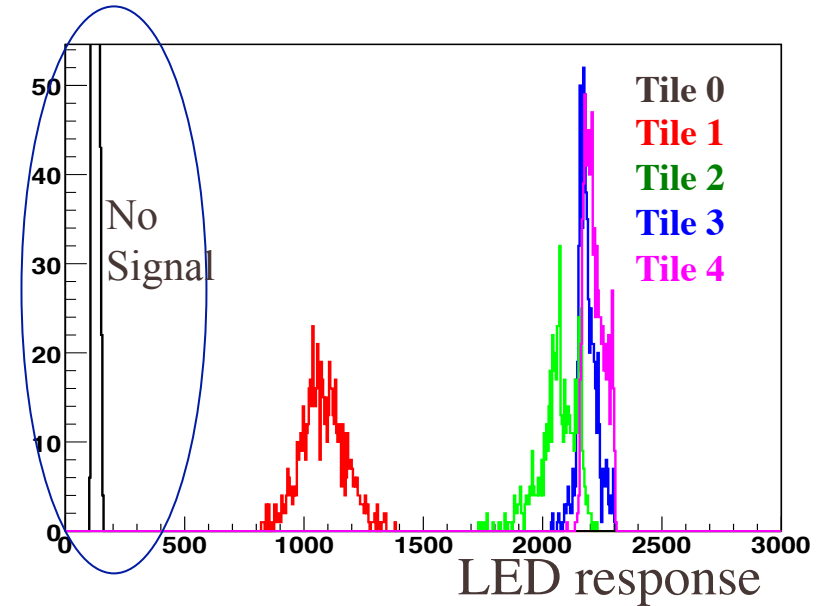
UV3TZ-405-30
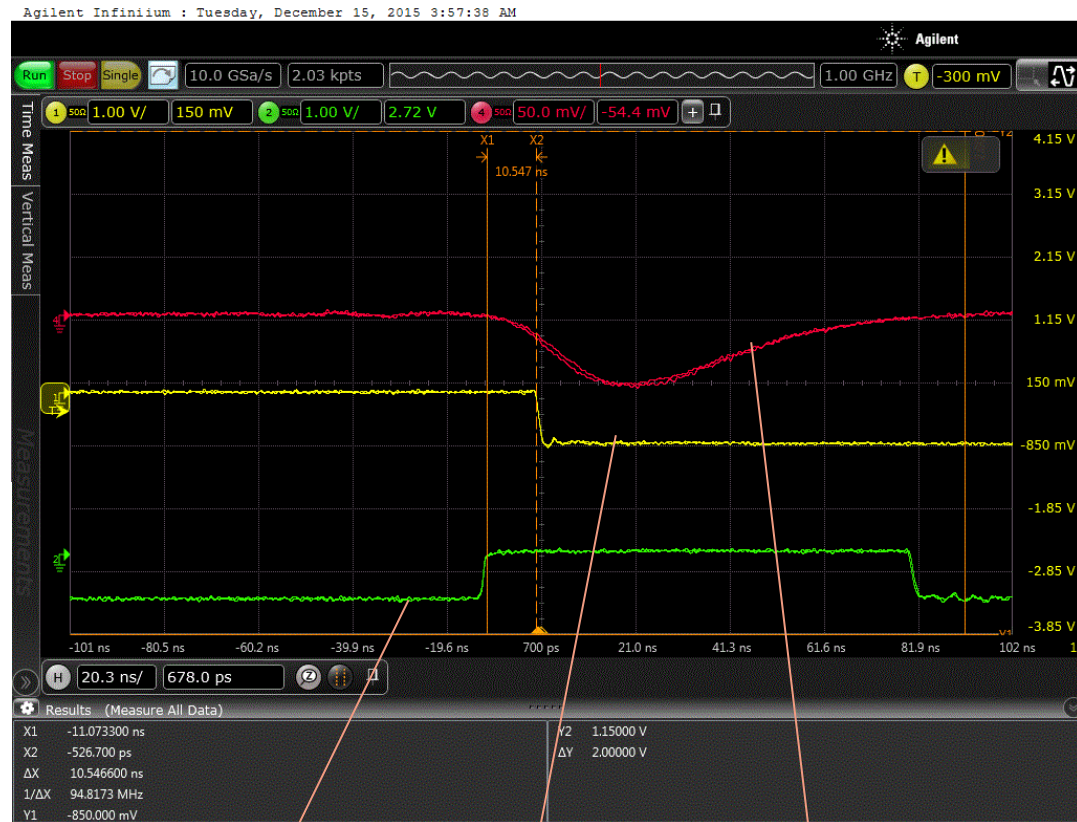
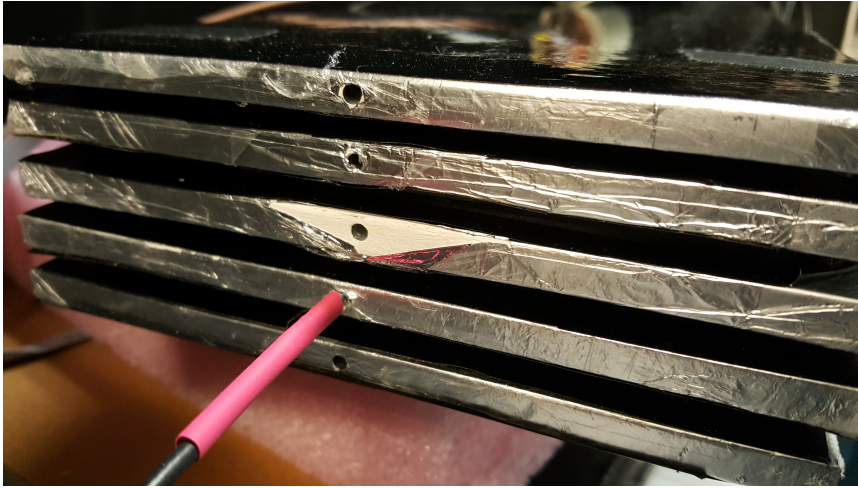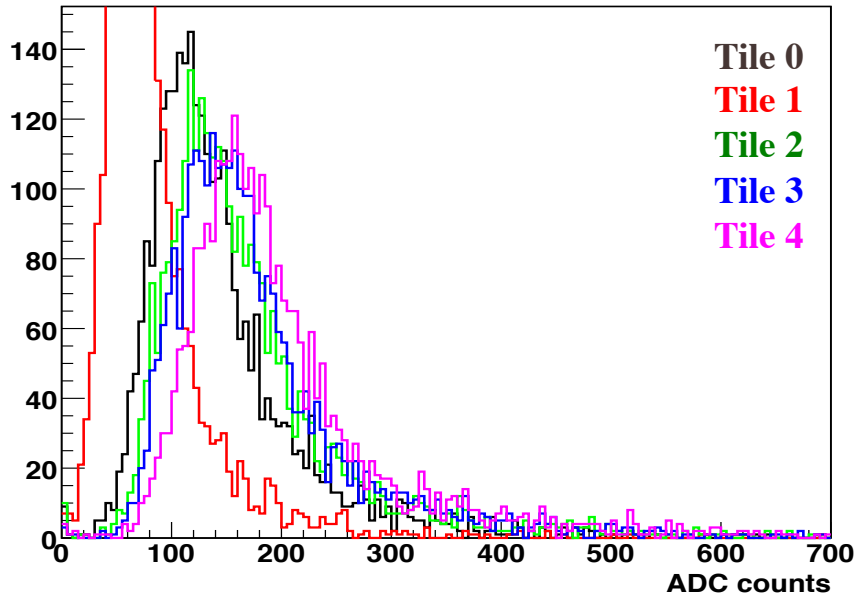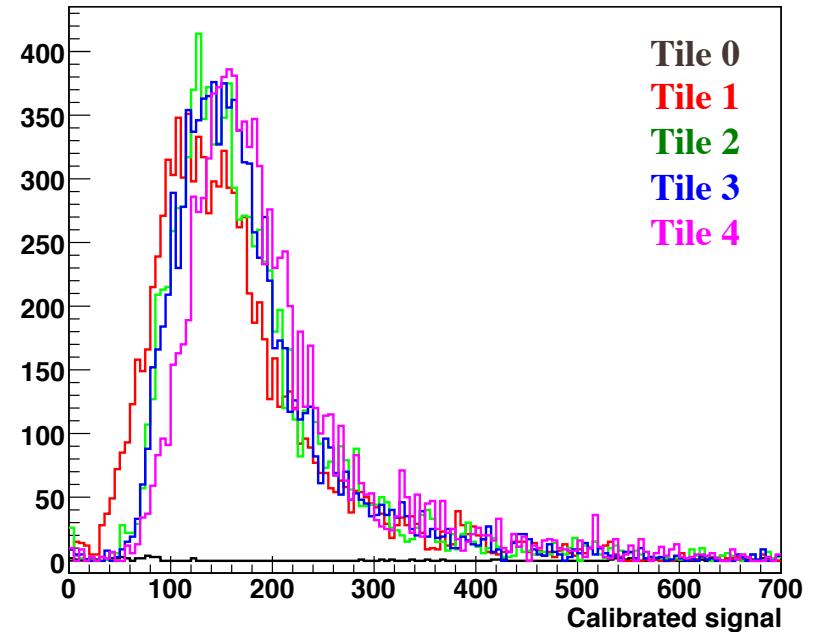**LED pulse**   **LED trigger**   **Tile response**

LED response

> ➤ We set it up on Monday, looked into the data while I was in airport. Tile 0 somehow has failed.
> ➤ Plugged in at the hole at narrow end.
> ➤ LED signal is similar to the response from cosmic.

Calibration

Before calibration — ADC counts; Tile 0, Tile 1, Tile 2, Tile 3, Tile 4

After calibration — Calibrated signal; Tile 0, Tile 1, Tile 2, Tile 3, Tile 4

➤ Take a reference tile (Tile 4 in this case) and normalize the tower with respect to that tile.

➤ All signal looks very consistent with each other.

➤ This is a very good way to calibrate the tiles to some extend.

Summary

❖ Still haven't started with actual test beam tiles. Waiting for some tiles get prepared.

❖ Light output is larger in the small tiles than long tiles.

❖ Large light output variation in the long tiles, which can be calibrated with LEDs in first pass.